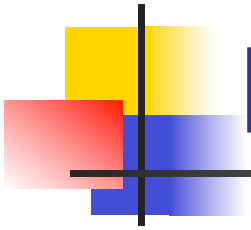
Enthalpy and Favourable Changes



Energy

- Key condition in favourable changes
- E.g., ball roll down the hill
- products have less enthalpy than reactants, the reaction releases energy
- i.e., exothermic, thus favourable
- But some endothermic reactions can be favourable.

Temperature

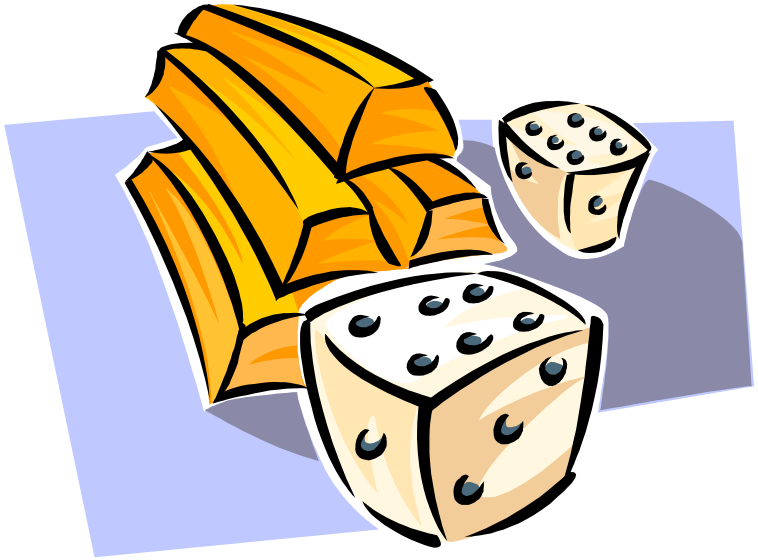
- $Hg\ (l) + \frac{1}{2}\ O_2\ (g) \longleftrightarrow HgO\ (s)$
- $\Delta H = \pm 90.8kJ$
- Left to right exothermic
- Enthalpy is negative
- Reaction will not take place (moderately)
- Above 400°C reverse reaction is favourable
- Direction of reaction proceeds depends on temperature

Entropy

- Temperature and enthalpy are not the only conditions which determine whether the reaction is favouable
- Entropy (S) is the tendancy toward randomness or disorder in a system
- An ordered arrangement of particles (atoms, ions, or molecules) has a lower entropy (small disorder)
- The state of pure substance increases entropy

Probability?

- Compare lots of random particles compared to a few.



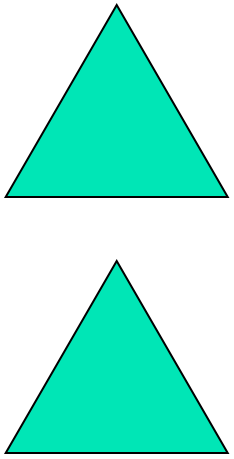
System is reactants and products

- Laws of thermodynamics
- 1st law is Law of Conservation of Energy
- Algebraic sum of energy changes in system and its system is equal to zero
- (Law?)
- But Entropy is not conserved

Entropy unsual

- Entropy favours increasing entropy
- 2nd Law of Thermodynamics
- The total entropy of the universe is constantly increasing
- **TOTAL**

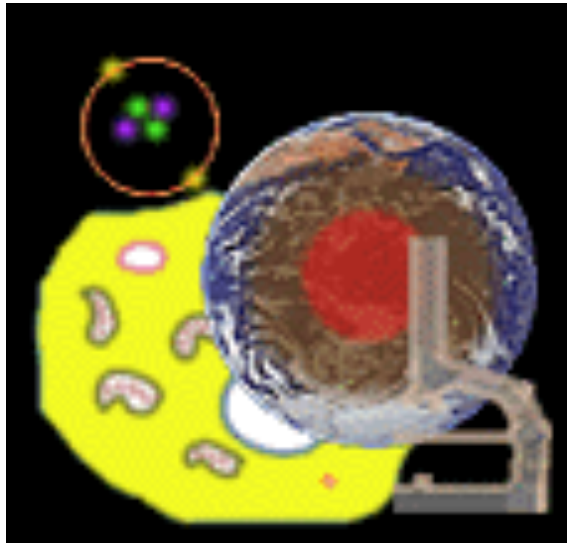
Entropy

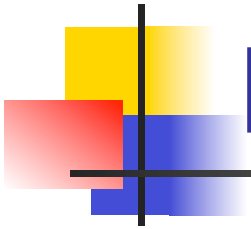


S (system) compared with

S (surrounding)

Life seeks out entropy





Entropy

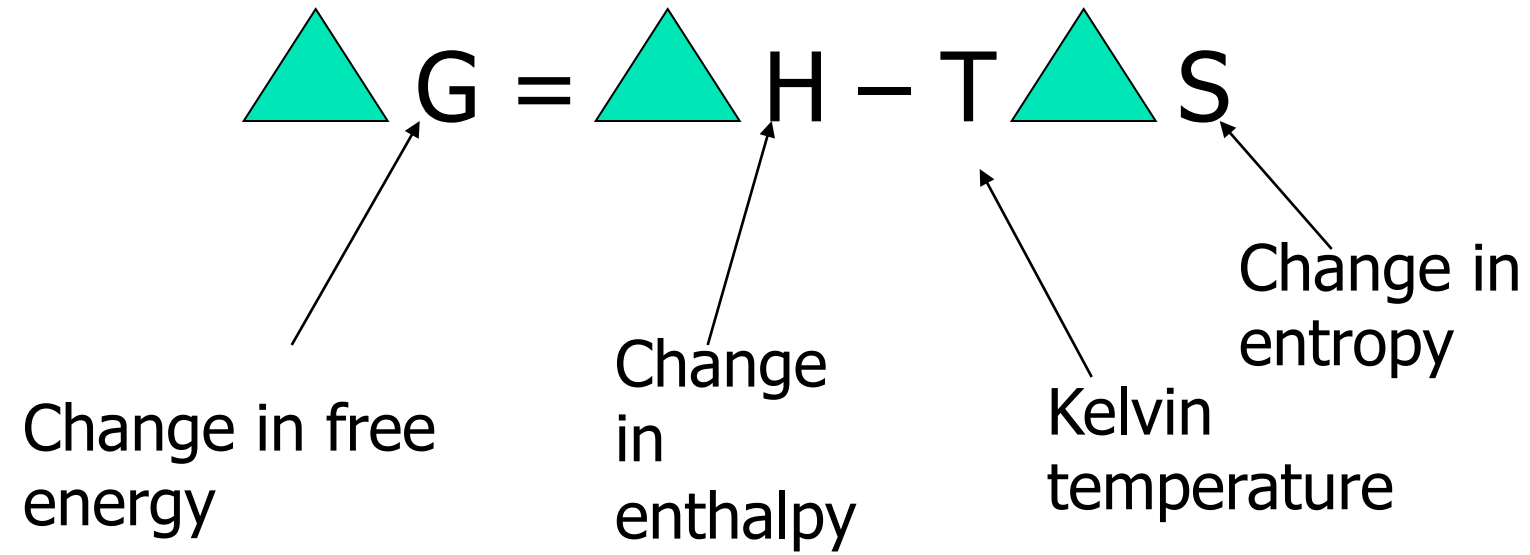
- All favourable changes involve an increase in the total amount of entropy
- Enthalpy, entropy and temperature are linked…

Free Energy and Equilibrium

- Free energy means available energy; and is a measure of useful work that can be obtained from the reaction
- Called Gibbs free energy
- (Josiah Willard Gibbs 1839 –1903; prof at Harvard University)

ΔG

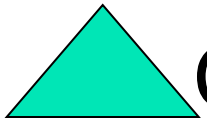
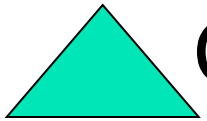
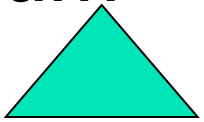
Equation


ΔG = ΔH – TΔS
Change in free energy
Change in enthalpy
Kelvin temperature
Change in entropy

The value of ΔG

- Tells us whether the reaction is source of useful energy
- Such energy can be converted into another form (e.g., mechanical)
- Δ G can help explain why some reactions are fav at room temp.

Change in free energy

- When  G is negative, the forward reaction if favourable
- When  G is zero, the reaction is at equilibrium
- When  G is positive, the reaction is favouable in the reverse direction but not in the forward direction

Example

- How does entropy of the system change?
- A) ice melting
- B) water vapour condensing
- C) $HCl\ (g) + NH_3\ (g) \longrightarrow NH_4Cl\ (s)$